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UTILIZATION OF AERIAL PHOTOGRAPHY

FOR THE GEOGRAPHIC STUDY OF THE DESERTS OF CENTRAL ASIA

COUNTRY: USSR

## TECHNICAL TRANSLATION

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Utilization of Aerial Photography for the Geographic  
Study of the Deserts of Central Asia

by  
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UTILIZATION OF AERIAL PHOTOGRAPHY  
FOR THE GEOGRAPHIC STUDY OF THE DESERTS OF CENTRAL ASIA

In the Soviet Union the development of methods for utilizing data from aerial photography and aerial visual observations for the study of the natural features of deserts was started a considerable time ago. This work was at first conducted by industrial organizations.

Thus, in 1933 the first successful attempt was made for utilizing aerial photography in order to prepare a geobotanic map for purposes of land management in the Northern Caspian area (Kunitsyn, 1934).

Special studies for the development of methods to utilize data from aerial photography for complex geographic studies was started in 1934 by the Central Scientific Research Institute of Geodesy, Aerial Photography and Cartography (GSNIIGAIK) in the Southwestern Turkmenistan, in the area of Mally Balkhan and Western Uzboy hills (V. P. Miroshnichenko, M. L. Steklova, V. V. Aleksandrov, and others).

In 1935 the development methods for special interpretation - geomorphologic, soil and geobotanic - was continued by a new expedition of GSNIIGAIK in the Southeastern Karakum (Rengarten, 1935; Petrov, 1936; 1944; and others).

Later, year after year, an increasing number of researchers of different specializations joined this work. In particular, the laboratory of aerial methods of the Academy of Sciences USSR organized in 1941 special studies for the further development of methods for interpreting aerial photographs in the deserts of Central Asia (Miroshnichenko, 1954, 1958, and 1960; Vinogradov, 1956 and 1958; and others).

Simultaneously with this, data from aerial photography came into use also for practical needs. These data were utilized particularly widely by the old Union Aerological Trust and by other organizations in detailed geological photography in the desert regions of Central Asia and in planning large irrigation projects in the deserts of Turkmenistan and Uzbekistan (Viktorov, 1947, 1955; Vostokova, 1955; Leont'yev, 1953; and others).

In agriculture, the utilization of data from aerial photography has found use in the study and utilization of pastures. In particular, much work has been done on the complex geobotanic and soil mapping of pastures and hay harvests of the Northern Caspian region (Tsatsenkin, 1952).

At the present time, problems of the utilization of data from aerial photography and aerial visual observations in the complex geographic study of desert and semi-desert areas of Central Asia and Kazakhstan, besides the indicated organization, is being conducted by a number of other scientific and industrial organizations - Moscow State University (A. F. Voronina and V. A. Nikolayev), the Institute of Geography of the Academy of Sciences USSR (B. A. Fedorovich) and others.

As a result of the above enumerated work, Soviet geographers have developed a procedure for interpreting aerial photographs and using these for special as well as for overall studies of the desert territories of the Soviet Union.

During recent years, Chinese geographers have started to study the natural features and natural resources of Central Asia in connection with the planning of railroads through the deserts and the utilization of minerals, the adaptation of virgin lands for agriculture, etc. In connection with this, the aerial photographic work has been carried out in a number of desert areas of Central China and over considerable areas.

The utilization of these data for geographic studies of the deserts of Central Asia can yield great advantage over ordinary terrestrial methods because many areas of the deserts are still difficultly accessible due to the lack of roads, lack of water, and strong development of shifting sands. In connection with this, it is natural to raise the question of the possibility of using methods developed by Soviet geographers who have been engaged in the utilization of data from aerial photography in the study of the desert of West Central Asia, under the conditions of the desert in East Central Asia.

During the summers of 1957 and 1958, in the course of a study of the deserts of Ordos and Alashan', the author, who was a member of expeditions by the Academy of Sciences of the Chinese Peoples Republic, was able to devote a part of the time to the interpretation of aerial photographs of these regions. Even the first results of this work have shown that the high effectiveness of the utilization of data from aerial photography in the deserts of East Central Asia is determined chiefly by the diversity of the geologic-geomorphologic structures. This is related to the complex geologic history of the Central Asiatic region and in particular by the change on its territory of the surface depositions of different age - on the most ancient pre-Cambrian crystalline rocks to the latest lacustrine-alluvial depositions. The complex interaction of the tectonic manifestations, denudation processes of the indigenous rocks, transfer and accumulation of the products of their destruction has led to the formation of diverse forms of the topography - low mountains and hillocks, accumulative plains, erosion valleys, and the eolian forms of topography.

These forms of topography do not occupy extensive territories but alternate rather frequently, creating sharp contrasts and combinations. In this respect, the deserts of East Central Asia differ significantly from the deserts of West Central Asia where single-type landscapes frequently occupy extensive territories, extending for hundreds of kilometers, for example, the white haloxylyns of the Karakum Lowlands or the wormwood-halophyte associations of Ustyurt. All this diversity of the forms and the topography in the nature of their distribution gives a rather rich and bright figure on the aerial photographs.

On the basis of this indication, which should be recognized as the leading one, in terrestrial work it was easy to characterize also other elements of the landscape. For this purpose, it was necessary to determine all the diversity of the indications in interpreting desert landscapes of East Central Asia by direct terrestrial operations.

The indications of the interpretation of the specific features in the geological structure, topography, and partly of the vegetative cover are direct. These are reflected sufficiently, rightly and clearly on the aerial photographs. Indications of the interpretation of the soil cover, hydrogeological characteristics, and sometimes also of the vegetation are indirect. The characterization of these elements of the landscape is accomplished rather easily by an analysis of the geomorphologic features of one or another section of the earth's surface.

Because of the lack of aerial photographs, I shall present a number of terrestrial photographs of the landscapes of the deserts and of East Central Asia, from which one can get some idea about their photogenic state.

The basic landscapes of the Ordos are the following types of deserts: pebble-sand deserts on the peaks and slopes of ridges of the indigenous topography with the eolian-alluvial cover (Figure 1); sand deserts overgrown and shifting barkhan, the eolian sands and salt-bottom deserts along the lacustrine basins or tsaydams (Figure 2). (The term tsaydam is derived from the Tibetan and is used locally to define a small brackish or salty lake.) The Arbiso and Sinchaoshan' hills form in the Western Ordos islands of dry desert hills with a rock debris desert. Sand deserts are the main type.

The basic specificity of the vegetative cover in the Ordos is the gradual transition from the northwest to the southeast, from vegetation of a desert nature to vegetation of a desert-steppe nature.

Within the limits of the elevated northwest and central drier desert Ordos, the vegetative cover has a typical desert appearance - the prevalence of small low bushes of xeromorphic appearance, highly sparse plants in assemblages, a considerable number of halophytes, etc.

Aerial photographs of the Ordos desert are very satisfactorily interpreted as landscapes of semi-overgrown and overgrown barkhan sands, with outcrops of indigenous rocks = cretaceous and Juassic sandstones, lacustrine basins with saline and fresh water lakes and surrounded by saline meadows.

## GRAPHICS NOT REPRODUCIBLE

Figure 1  
Flat peak of indigenous ridge of cretaceous sandstone with sparse herbaceous vegetation. Central Ordos (1957).

The masses of the barkhan sands are the youngest landscape not only in the Ordos but in any other deserts on the earth. They preserve and East Central Asia also their specific appearance of parallel or reticularly distributed bent lines with characteristic dark lines of the shadowed slopes with waste. A characteristic feature of the view of the barkhan chains are the lines of the extent of the barkhan chains, which are determined by the action of the predominant winds that form these.

In this respect, the deserts of East Central Asia are divided rather clearly into two extensive regions - Eastern, where northwestern winds predominate and which form barkhan chains from the northeast to the southwest (Figure 3), and a Western, with predominance of northeasterly winds.

The landscapes of the green-wormwood associations of overgrown and sandy overgrown sands give on aerial photographs with a scale of 1:30,000 a clear fine-point picture, more sparse in the sandy overgrown sands, more dense in the overgrown sands.

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Figure 2  
Lacustrine basin with saline meadow. Central Ordos (1957).

Figure 3  
Diagram of distribution of crests of the barkhan chains in the  
Ordos Desert. Prepared from aerial photography in 1957).

Lacustrine depressions show up particularly as a result of the presence therein of flakes and salt-bottoms as well as small masses of barkhan sands. These landscapes give a contrasting picture with respect to the tone of the image and the figure. As an example, I would like to show a

# GRAPHICS NOT REPRODUCIBLE

picture of landscapes of one of the lakes located in the center of the Ordos, prepared from aerial photographs of a 1:30,000 scale (Figure 4).



Figure 4  
Landscapes of the lacustrine basin in the Central Ordos.  
a) lake with salt depositions; b) saline meadow  
with bean caper; c) half crushed hillocky sands overgrown  
with Ordos wormwood; d) barkhan sands almost completely  
devoid of vegetation; e) elevated plain with shallow  
occurrence of cretaceous sandstone covered with an eolian-  
alluvial sheet.

The dry beds of temporary floods, which are related with lacustrine depressions, are delineated on aerial photographs by the bright tone of the salt-bottoms and are easily delineated by the escarpments of the shores of the surrounding landscapes.

The rather frequent outcrops of indigenous rocks in the Ordos - the juvassic and cretaceous sandstone-along the slopes of the lacustrine depressions give on the aerial photographs a clear picture underscored by shadows.

The least definite picture is given by the image of one of the basic landscapes in the Ordos - pebble-sand elevations of the plains. This is determined by the flat topography and the intensely sparse herbaceous vegetation, which are not reflected on the aerial photographs. However, the determination of the boundaries of this landscape causes no great difficulties because all other landscapes have on this background their clear limits. Because of this, the landscapes of the pebble-sand deposits are then delineated on the aerial photographs by the exclusion method.

The Alashan' desert is less complex with respect to the landscape. The nature of its surface depositions, depending on the characteristics of the geological structure, is quite highly diverse. In accordance with this, one can separate here the following types of deserts: rock debris deserts on the low-hill chains of Yaburai, Bain-Nor, Bain-Ule, and others (Figure 5), sand-pebble deserts (Gobi) on the tertiary plains (Figure 6), sand deserts with fixed or shifting barkhan sands and salt-bottom deserts along the lacustrine depressions or the tsaydams. The main type of desert is, just as in the case of the Ordos, the sand desert which consists predominantly of barkhan sands. The entire territory of the Alashan' is impregnated with extensive small lacustrine depressions - tsaydams. As a result of the shallow ground waters, a marshy meadow salt-bottom and salt-bottom vegetation is developing in these. These locations are usually the support bases of the animal population with rather large (for a desert) populated points.

In dry fluvial weakly cut valleys, remnants of a once luxurious forest tugay vegetation have been preserved (tugay is a term borrowed from the Turkish languages and means woods running along the lowlands parallel to a river) - sparse thickets or single elms (124A) (Figure 7) and heterophyllous poplar - Asiatic poplar (124B). In places along the broad depressions, considerable areas are taken up by sparse thickets of haloxylons (124C) (Figure 8).

On the aerial photographs, the entire variety of the enumerated landscapes of the Alashan' desert is reflected very clearly. The low hills and the small mud volcanoes give the usual type clear picture of well shadowed rocky or small round hilly elevations. The picture of barkhan sands has generally the same nature as in the Ordos, with the same orientation of the barkhan chains. The barkhan sands, which are overgrown with wormwood, have a darker fine-grain background and partly preserve their characteristic orientation of the rounded forms of the barkhan topography.

The thickets of the haloxylon show up well on the aerial photographs, giving clear punctuate pictures. In this respect, they are very similar with the image on the aerial photographs of thickets of the black haloxylon in the Karakum desert. Single smooth-leaved elms are also delineated on the aerial photographs very clearly.

Landscapes of tsaydams - depressions with comparatively shallow occurrence of ground waters - differ sharply from the surrounding areas of barkhan sands and sand-pebble plains (Gobi) which are richer in vegetation, in particular in thickets of Tangut and Siberian beam caper, which form sands and reeds, with considerable areas of salt-bottoms and sometimes during periods of strong rain, by the presence of water in the center of the depression. All this diversity of the natural boundaries of the tsaydams is clearly reflected on the aerial photographs in the tone and picture and is easily interpreted.

**GRAPHICS  
NOT REPRODUCIBLE**

Figure 5

The Bain-Ule low hill area in the eastern section of the Alashan' desert (1958).

**GRAPHICS  
NOT REPRODUCIBLE**

Figure 6

Escarpment of the sand-pebble plain (Gobi) in the dry valley. The eastern part of the Alashan' desert (1958).

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Figure 7  
Single trees of hailas or smooth-leaved elm (*Ulmus pumila L.*) in  
the dry river bed. Northern section of the Alashan' desert (1958).

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Thickets of Zaysan haloxylon with sparce separations. Eastern  
section of the Alashan' desert (1958).

One of the main landscapes of the Alashan' desert - the sand-pebble plains (Gobi) - is shown least clearly on the aerial photographs. This is determined by the plains nature of the topography and by the sparse low bush vegetation which is practically not fixed on the aerial photographs. However, establishment of the Gobi boundaries on the aerial photographs usually presents no special difficulties, because its surrounding landscapes are themselves very well delineated on the aerial photographs. As a result of this, the exclusion method is used to determine also sections occupied by the Gobi.

The southern boundary of the Alashan' desert, in passing from it to the foothill plain of Nan'shan' (Chinlinshan'), are expressed particularly clearly on the aerial photographs. In the contact zone, the landscapes are the shifting barkhan and overgrown sands are alternated by pebble or loam-pebble foothill plains with numerous dry riverbeds. A portion of these plains has been utilized for agriculture, a portion is occupied by natural bush desert or desert-steppe vegetation. The transition zone between the foothill plain and the Alashan' desert is occupied by large- and small-area sands with Tangut bean caper.

Each of the described landscapes is shown on the aerial photographs very clearly by the tonality as well as by the picture. For this reason, despite a complexity of the line of the southern boundary of the Alashan' desert, it is interpreted very easily on the aerial photographs (Figure 9).

## GRAPHICS NOT REPRODUCIBLE

Figure 9

Contact zone of southern edge of the Tenger desert (southeastern part of the Alashan' desert) with oasis of the northern foothills of Chinlinshan'. Prepared from aerial photographs.  
a) barkhan sands; b) large-heap sands with Tangut bean caper;  
c) small-heap sands with Tangut bean caper; d) agricultural oasis with planted field crops.

The landscapes of the Beishan' desert have a number of specific features; these differ from the Ordos and the Alashan' with their intensive desert condition.

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**Figure 10  
Pebble desert (Gobi) in the southern part of Beishan' (1958).**

**GRAPHICS  
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**Figure 11  
Rock debris desert in the foothills and small mud volcanoes of Beishan'  
(1958).**

In the Beishan', the distribution of the vegetation is affected chiefly by the topography in the nature of the soils and related distribution of the sparse atmospheric precipitation. In the climatic respect, the entire territory of the Beishan' is of one type and has a desert climate, with the exception of its central part which is the highest (altitude 2791 meters), where the amount of precipitation should be greater than in the peripheral regions. On the territory of the Beishan' one can delineate the following types of deserts: pebble (Gobi) (Figure 10), rock debris, sand (in the northeastern part), and salt-bottom deserts. The main desert type comprises the rock debris deserts (Figure 11). The salt-bottom deserts are very rare here.

The vegetative cover of the Beishan' deserts is the poorest in a floristic respect as well as with respect to the degree of propagation of the vegetation. Usually, the plants here are scattered in small groups or singly over the sand-pebble and rock debris plains or low hills. Here one encounters the most xerophytic plants for the entire east central Asia (129A) and others. In places which extend for hundreds of meters and kilometers, the vegetation is entirely absent.

The vegetation is much richer in dry river beds where the soil cover is sometimes as high as 25-30%. Here one encounters, besides the above indicated plants, large pea brush (129B), wolfberry (129C), calligonum (129D), and others.

Along the more damp beds and near springs, of which there are rather many and in the higher low-hill part, the vegetation is more mesophytic and richer in a floristic respect as well as with respect to the number of plants. Here, one can encounter representatives of the tugay flora of the east and west central Asia - poplar - Asiatic poplar (129E), elaeagnus (129F), camel's thorn (129G), and others. Zaysan haloxylon is usual in the drier sections of the interhill depressions.

On the aerial photographs, the pebble plains (Gobi) give a single-tone background which is somewhat complicated by the lines of the dry beds with richer brush vegetation. The low mountain relief and the small mud cones are delineated more clearly as a result of the shadowing of the forms of their relief. The bumper between these is drawn very clearly.

The valleys of the rivers Huanhe, Edzingol, Sulahe, and others, which intersect or skirt the above described deserts, comprise a sharp contrast with the desert regions.

Particularly distinguishable are the landscapes of the irrigated oases with their luxurious forest vegetation, field plots, and irrigation network.

The interpretation of such territories from aerial photographs is carried out without any special difficulties and it has much in common with the methods of interpretation of river valleys and oases in the desert zone of West Central Asia.

The above presentation makes it possible to conclude that the work on the use of aerial photography in the deserts of East Central Asia, in comparison with the deserts of West Central Asia, has nothing basically new. For this reason, the methods developed by Soviet scientists who use aerial photography in geographic studies of the territory of the deserts of the Soviet Union, could successfully be used also in East Central Asia. It is necessary to disseminate widely these methods and achievements in order to introduce these into geographic work in studying the tremendous territory of the deserts in the Chinese Peoples Republic.

The use of aerial photography for studying and utilizing deserts of East Central Asia has tremendous possibilities and should find in the near future wide application in all types of geographic situations of these deserts. One of the most valuable characteristics of aerial photography is the possibility of the wide utilization for a number of branches of science, and agriculture and industry. The same photographic systems can be processed for different scientific and industrial purposes. In view of this, the resulting planning material makes it possible to prepare a number of detailed maps which are essentially necessary in the operating work of animal husbandry and other organizations that are related with the development of the desert riches, maps of oil bearing structures, types of pastures, roads and paths, wells, thickets of haloxylon, self shifting sands, etc.

As regards the value and prospects of aerial photographic work in individual branches of agriculture, which are related with the utilization of the vegetation of deserts, it is necessary for us to dwell on the pasture economy of the deserts in East Central Asia. It is quite widely known that its tremendous pasture territories, which support multimillion heads of cattle, have been studied and mapped rather schematically. The reason for this is the lack of more or less accurate maps and the great extent of the deserts.

Aerial photography, however, yields planning material on the scale of 1:25,000 or 1:50,000, which is more than sufficient for economic purposes. This will make it possible in the shortest period of time to accomplish the complex and painstaking work in recording the pasture resources, organizing pasture rotations, etc.

In the timber industry, aerial photography will give planning data which will make it possible to evaluate the nature of the distribution of haloxylon thickets and their confinement to the proper types of habitats. These data could form the basis of range management. In this case, the use of aerial photography, because of the representation of large-brush vegetation even on a scale of 1:16,000, can yield much. On the basis of data in our posession, which encompass the basic masses of the black haloxylon in the Alashan' desert, we were able to become convinced not only of the ease of the determination of the boundaries of propagation of pure haloxylon thickets, but also the possibility of determining the density of the plantings.

It is no less important to have detailed plans of the distribution of the masses of mobile sands in organizing measures to combat these so as to obtain a more efficient distribution of protective structures for sowings and plantings and constant control of their functioning. This will make it possible to a considerable degree to raise the effectiveness of the sand-fixation operations.

Considering that the most harmful mobile sands which border with the arable lands in the valleys of the river Huanhe and of the rivers in the Hesi corridor have presently always been mapped, it is necessary for the agricultural and timber and soil improvement organizations to take this into account and to utilize in every possible way the data of aerial photography in their operative work.

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Aerial photographic work in the deserts of East Central Asia, in comparison with the deserts in West Central Asia, does not differ basically. The methods of Soviet scientists to utilize aerial photography in the geographic studies on the desert territories of the Soviet Union could successfully be used also in East Central Asia. It is necessary to disseminate widely these methods and achievements in order to introduce these into geographic studies of the tremendous desert territories of the Chinese Peoples Republic.

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